CLAIMS

1. A magnetic sensor comprising:

an antiferromagnetic layer extending in a track-width direction;

a ferromagnetic layer disposed over the antiferromagnetic layer, the ferromagnetic layer having a magnetization that remains substantially fixed in response to an applied magnetic field and extending in the track-width direction to terminate in a first end;

a magnetically soft layer disposed over the ferromagnetic layer, the magnetically soft layer having a magnetization that rotates in response to the applied magnetic field, the magnetically soft layer extending in the track-width direction to terminate in a second end, the first and second ends forming part of a junction;

a cap layer disposed over the magnetically soft layer such that the junction has a slope of less than forty-five degrees when measured at a location seven nanometers below a top of the cap layer;

a magnetically hard layer disposed adjacent to at least the second end, the magnetically hard layer having a magnetization that remains substantially fixed in response to the applied magnetic field, to stabilize the magnetization of the end of the magnetically soft layer; and

an underlayer disposed between the antiferromagnetic layer and the magnetically hard layer.

2. The sensor of claim 1, wherein the underlayer has a thickness that is at least eighty-percent as large as the thickness of the adjacent magnetically hard layer.

3. The sensor of claim 1, wherein the underlayer has a thickness that is at least as large as the thickness of the adjacent magnetically hard layer.

4. The sensor of claim 1, wherein the underlayer includes an amorphous layer and a crystalline layer.

5. The sensor of claim 1, wherein the underlayer includes an electrically conductive amorphous layer and a crystalline layer.

6. The sensor of claim 1, wherein the underlayer includes an electrically insulating amorphous layer and a crystalline layer.

7. The sensor of claim 1, wherein the underlayer and magnetically hard layer have a combined thickness that is at least about three-quarters the height of the junction.

8. The sensor of claim 1, further comprising an electrically conductive, nonmagnetic layer disposed between the ferromagnetic layer and the magnetically soft layer.

9. The sensor of claim 1, further comprising a dielectric layer disposed between the ferromagnetic layer and the magnetically soft layer.

10. The sensor of claim 1, further comprising a resistive layer disposed between the ferromagnetic layer and the magnetically soft layer.

11. The sensor of claim 1, further comprising a magnetically soft shield, and an electrically insulating read gap layer adjoining the magnetically soft shield and the antiferromagnetic layer, wherein the read gap layer has a uniform thickness.

12. The sensor of claim 11, wherein the read gap layer thickness is about fifty nanometers or less.

13. A magnetic sensor comprising:

an antiferromagnetic layer extending a first distance in a track-width direction;

a ferromagnetic layer disposed over the antiferromagnetic layer, the ferromagnetic layer having a magnetization that remains substantially fixed in response to an applied magnetic field;

a magnetically soft layer disposed over the ferromagnetic layer, the magnetically soft layer having a magnetization that rotates in response to the applied magnetic field, the magnetically soft layer extending a second distance in the track-width direction, the second distance being not more than half the first distance;

a magnetically hard layer disposed adjacent to an end of the magnetically soft layer, the magnetically hard layer having a magnetization that remains substantially fixed in response to the applied magnetic field, to stabilize the magnetization of the end of the magnetically soft layer; and

an underlayer disposed between the antiferromagnetic layer and the magnetically hard layer.

14. The sensor of claim 13, wherein the underlayer has a thickness that substantially aligns the magnetically hard layer and the magnetically soft layer.

15. The sensor of claim 13, wherein the underlayer has a thickness that is at least about as large as the thickness of the adjacent magnetically hard layer.

16. The sensor of claim 13, wherein the underlayer includes an amorphous layer and a crystalline layer.

17. The sensor of claim 13, wherein the underlayer includes an electrically conductive amorphous layer and a crystalline layer.

18. The sensor of claim 13, wherein the underlayer includes an electrically insulating amorphous layer and a crystalline layer.

19. The sensor of claim 13, wherein the end forms part of a contiguous junction, and the underlayer and magnetically hard layer have a combined thickness that is at least about three-quarters the height of the contiguous junction.

20. The sensor of claim 13, further comprising an electrically conductive, nonmagnetic layer disposed between the ferromagnetic layer and the magnetically soft layer.

21. The sensor of claim 13, further comprising a dielectric layer disposed between the ferromagnetic layer and the magnetically soft layer.

22. The sensor of claim 13, further comprising a resistive layer disposed between the ferromagnetic layer and the magnetically soft layer.

23. The sensor of claim 13, further comprising a magnetically soft shield, and an electrically insulating read gap layer adjoining the magnetically soft shield and the antiferromagnetic layer, wherein the read gap layer has a uniform thickness.

24. The sensor of claim 23, wherein the read gap layer thickness is about fifty nanometers or less.

25. A magnetic sensor comprising:

an antiferromagnetic layer extending in a track-width direction;

a ferromagnetic layer disposed over the antiferromagnetic layer, the ferromagnetic layer having a magnetization that remains substantially fixed in response to an applied magnetic field and extending in the track-width direction;

a magnetically soft layer disposed over the ferromagnetic layer, the magnetically soft layer having a magnetization that rotates in response to the applied magnetic field, the magnetically soft layer extending in the track-width direction to terminate in an end, such that the antiferromagnetic layer, ferromagnetic layer and magnetically soft layer form a stack having a thickness that is less than an amount that the antiferromagnetic layer extends in the track-width direction beyond the end;

a magnetically hard layer disposed adjacent to the end, the magnetically hard layer having a magnetization that remains substantially fixed in response to the applied magnetic field, to stabilize the magnetization of the end of the magnetically soft layer; and

an underlayer disposed between the antiferromagnetic layer and the magnetically hard layer.

26. The sensor of claim 25, wherein the underlayer has a thickness that substantially aligns the magnetically hard layer and the magnetically soft layer.

27. The sensor of claim 25, wherein the underlayer has a thickness that is at least about as large as the thickness of the adjacent magnetically hard layer.

28. The sensor of claim 25, wherein the underlayer includes an amorphous layer and a crystalline layer.

29. The sensor of claim 25, wherein the underlayer includes an electrically conductive amorphous layer and a crystalline layer.

30. The sensor of claim 25, wherein the underlayer includes an electrically insulating amorphous layer and a crystalline layer.

31. The sensor of claim 25, wherein the end forms part of a contiguous junction, and the underlayer and magnetically hard layer have a combined thickness that is at least about three-quarters the height of the contiguous junction.

32. The sensor of claim 25, further comprising an electrically conductive, nonmagnetic layer disposed between the ferromagnetic layer and the magnetically soft layer.

33. The sensor of claim 25, further comprising a dielectric layer disposed between the ferromagnetic layer and the magnetically soft layer.

34. The sensor of claim 25, further comprising a resistive layer disposed between the ferromagnetic layer and the magnetically soft layer.

35. The sensor of claim 25, further comprising a magnetically soft shield, and an electrically insulating read gap layer disposed between the magnetically soft shield and the antiferromagnetic layer, wherein the read gap layer has a uniform thickness.

36. The sensor of claim 35, wherein the read gap layer thickness is not more than about fifty nanometers.

37. A magnetic sensor comprising:

an antiferromagnetic layer extending a first distance in a track-width direction;

a ferromagnetic pinned layer disposed over the antiferromagnetic layer;

a ferromagnetic free layer disposed over the pinned ferromagnetic layer, the free layer having a magnetization that rotates due to an applied magnetic field, the free layer extending a second distance between two ends in the track-width direction, the second distance being not more than half the first distance;

a pair of magnetically hard bias layers, each bias layer disposed adjacent to a different one of the ends and providing a magnetic field to stabilize the magnetization of the adjacent end; and

a pair of underlayers, each underlayer disposed adjacent to a different one of the hard bias layers to increase alignment between the adjacent bias layer and the free layer.

38. A magnetic sensor comprising:

an antiferromagnetic layer extending a first distance in a first direction;

a ferromagnetic layer disposed over the antiferromagnetic layer, extending in the first direction to terminate at a junction, and having a magnetization that remains substantially fixed in response to an applied magnetic field;

a magnetically soft layer disposed over the ferromagnetic layer, the magnetically soft layer having a magnetization that rotates due to the applied magnetic field, the magnetically soft layer extending a second distance between two ends in the first direction, the second distance being not more than half the first distance;

a pair of magnetically hard layers, each magnetically hard layer disposed adjacent to a different one of the ends and providing a magnetic field to stabilize the magnetization of the adjacent end; and

a pair of underlayers, each underlayer disposed adjacent to a different one of the hard bias layers to increase alignment between the adjacent bias layer and the magnetically soft layer.

39. A magnetic sensor comprising:

an antiferromagnetic layer extending in a track-width direction;

a ferromagnetic layer disposed over the antiferromagnetic layer, the ferromagnetic layer having a magnetization that remains substantially fixed in response to an applied magnetic field and extending in the track-width direction;

a magnetically soft layer disposed over the ferromagnetic layer, the magnetically soft layer having a magnetization that rotates in response to the applied magnetic field, the magnetically soft layer extending in the track-width direction to terminate in an end, such that the antiferromagnetic layer, ferromagnetic layer and magnetically soft layer form a stack having a thickness that is less than an amount that the antiferromagnetic layer extends in the track-width direction beyond the end;

a magnetically hard layer disposed adjacent to the end, the magnetically hard layer having a magnetization that remains substantially fixed in response to the applied magnetic field, to stabilize the magnetization of the end of the magnetically soft layer; and

an underlayer disposed between the antiferromagnetic layer and the magnetically hard layer.